

**Draft Interpretative Memorandum on Stabilization of Organic-Bearing
Hazardous Wastes to Comply with RCRA Land Disposal Restrictions**

Summary

Members of the regulated community as well as other regulatory agencies have asked on several occasions whether, under current Land Disposal Restriction (LDR) treatment regulations, the treatment standards for hazardous organic constituents can be met using stabilization technologies¹ or whether such treatment would always be a type of impermissible dilution. We are providing this interpretative memorandum² under the Resource Conservation and Recovery Act (RCRA) to give further clarification on this question. Although these issues are often fact-specific, this memorandum discusses circumstances where stabilization of hazardous organic constituents is likely to be classified as impermissible dilution and sets forth additional factors to consider when making this case-by-case evaluation. We also discuss situations where stabilization of hazardous organic constituents³ could be a permissible form of treatment.

This interpretative memorandum is intended to set out broad principles to be considered wherever LDR requirements apply. However, we do not intend to apply any of the general

¹ For LDR purposes, stabilization is described in 40 CFR §268.42 under the technology treatment standard identified as STABL and the Treatment Technology Background Document (January 1991). More generally, stabilization refers to converting a waste to a more chemically stable form, which almost always involves the use of a physicochemical reaction to transform hazardous constituents to a less mobile or less toxic form. Solidification refers to a process in which materials are added to the waste to produce a solid, which may or may not involve a chemical bonding between the toxic constituent and the additive. The two terms are not necessarily mutually exclusive since stabilization may include solidification and vice versa. See Technical Resource Document, Solidification/Stabilization and its Application to Waste Materials, EPA/530/R-93/012, USEPA Office of Research and Development (June 1993). For the purpose of this memorandum, the term stabilization encompasses solidification treatment technologies as well.

² This memorandum does not address issues involving treatment variances. Standards for doing so are provided in 40 CFR §268.44.

³ For the purpose of this memorandum, hazardous organic constituents are those organic compounds for which EPA has established a treatment standard under 40 CFR §268.40.

concepts discussed in this memorandum to re-open decisions involving remediations which have already occurred or where the course of remediation has been determined conclusively. Thus, insofar as remediations under CERCLA Response Actions, RCRA corrective actions, and RCRA closures are concerned, this memorandum provides clarification for only those Records of Decisions, remedy selections, and closure approvals that are developed after the signature date of this memorandum.

A. What Is The General LDR Prohibition Against Impermissible Dilution?

The general LDR prohibition against impermissible dilution applies to the treatment standards for hazardous constituents⁴ and provides that no generator, transporter, handler, or owner or operator of a treatment, storage, and disposal facility shall dilute a hazardous waste as a substitute for adequate treatment to achieve compliance with the LDR treatment standards. See 40 CFR §268.3. This regulatory prohibition is based on the statutory command in section 3004(m) which requires that treatment substantially reduce the mobility or toxicity of hazardous constituents, see Chemical Waste Management v. EPA, 976 F. 2d 2, 17-18, 22-25, as well as on explicit legislative history. See S. Rep. No. 98-284, 98th Cong. 1st sess. 17. These authorities state that dilution of hazardous constituents without treatment which destroys, removes, or immobilizes them fails to satisfy the fundamental statutory requirement that threats posed by land disposal be “minimize[d]” before the wastes are land disposed. RCRA section 3004(m)(1). We have previously identified instances of impermissible dilution that include: complying with the treatment standards by mixing wastes, mixing wastes that result in a change of treatability groups

⁴ It is permissible to use dilution to remove the properties of ignitability, reactivity, or corrosivity, although not to treat any underlying hazardous constituents which may be present in those wastes. See generally Chemical Waste Management v. EPA, 976 F. 2d 2, 15-18 (D.C. Cir. 1992).

(e.g., mixing a non-debris hazardous waste with debris material), adding excessive quantities of reagents to wastes, and treating wastes by ineffective or otherwise inappropriate technologies. See 53 FR 31138, 31145 (August 17, 1988), 54 FR 48372, 48494 (November 22, 1989), 57 FR 37194, 37224 (August 18, 1992), and 61 FR 15566, 15586 (April 8, 1996).

One example of impermissible dilution is when stabilization reagents are added in excessive quantities such that the hazardous constituents (inorganics and organics) are merely diluted by the reagents or additives to the point of meeting the numerical Universal Treatment Standard (UTS) levels and no reduction in the mobility (i.e., leachability) of constituents in the stabilized matrix occurs. However, dilution that is a necessary part of the treatment process, which otherwise destroys, removes, or immobilizes the hazardous constituents, is normally permissible. See 51 FR 40572, 40592 (November 7, 1986); 62 FR at 37694, 37697 (July 14, 1997).

More recently, we determined that impermissible dilution occurs when iron filings are used to ‘treat’ lead-containing wastes. This waste management practice does not minimize threats posed by the land disposal of lead-containing hazardous wastes because the practice essentially ‘blinds’ the analytic method and does not prevent the lead from leaching under actual disposal conditions. See 63 FR 28556, 28566 (May 26, 1998).

The next section of this memorandum explains in some detail when, for purposes of LDR compliance, EPA would consider stabilization of organic wastes and contaminated soils to be impermissible dilution and, therefore, in violation of the dilution prohibition in 40 CFR §268.3.

B. When Is Stabilization Of Organic Constituents Likely To Be Considered Impermissible Dilution?

The LDR treatment regulations do not specifically prohibit the use of stabilization to treat hazardous wastes containing organic constituents, but, as just explained, 40 CFR §268.3 contains the overarching prohibition against impermissible dilution discussed above. The result is that one cannot comply with the LDR treatment standards for hazardous constituents through impermissible dilution regardless of the acceptability of a treatment technology when used in other circumstances (e.g., stabilization of metal wastes to reduce the mobility of hazardous metal constituents).

Discussed below first are situations in which stabilization of hazardous organic constituents is likely to be a type of impermissible dilution. We then discuss considerations and situations pertinent to an evaluation of whether stabilization of hazardous organic constituents may be a permissible form of treatment (i.e., likely would not constitute impermissible dilution).

1. Situations When Stabilization of Hazardous Organic Constituents Would Likely Be Impermissible

We have identified two specific situations in which stabilization of hazardous organic constituents is likely impermissible under 40 CFR §268.3. Other circumstances may also raise the issue of impermissible dilution and must be resolved on a case-by-case basis by the implementing regulatory agency.

(a) Impermissible dilution likely occurs when stabilization technologies are operated such that hazardous organic constituents are released to air in an uncontrolled manner at levels that pose an unacceptable risk to human health or the environment. In the stabilization process, the addition of reagents often requires a significant amount of physical mixing of the waste with the reagents and since heat is often generated when highly alkaline reagents (e.g., lime and quicklime) are added during the process, a significant amount of volatile organics and some semi-volatile organics can

be vaporized. See 61 FR 59932, 59945 (November 25, 1996) (summarizing data showing that stabilization operations can release environmentally significant concentrations of volatile hazardous constituents which require control to avoid harm to human health and the environment). In this sense, some stabilization technologies can provide some removal of organics, but potentially in a manner that constitutes impermissible dilution. Cf. Chemical Waste Management v. EPA, 976 F. 2d at 17 (treatment process with uncontrolled air emissions can be a type of impermissible dilution, or can otherwise be impermissible because it fails to minimize threats). In essence, the ambient air is the diluting mechanism.

If volatile and semi-volatile organics released into the air are, however, captured and destroyed such that any emissions of these constituents were determined not to pose an unacceptable risk to human health or to the environment, impermissible dilution to air would not occur. We note that the Agency's rules in 40 CFR Parts 264 and 265 Subpart CC (establishing standards for control of air emissions from hazardous waste tanks, containers and surface impoundments) set out the usual measure of control for such air emissions to prevent these unacceptable risks⁵. These rules were, in some cases, specifically tailored to provide flexibility for stabilization operations where the wastes contained volatile hazardous constituents. See, e.g., 40 CFR §264.1084. Thus, we would likely conclude that stabilization units treating hazardous wastes with hazardous organic constituents, which meet numerical treatment standards after treatment and which capture and destroy the hazardous organic constituents in conformance with subpart CC standards, are engaged in a permissible form of treatment. This is a common sense

⁵ We also note that Subpart CC does not apply to tanks, containers, and surface impoundments that solely manage remediation wastes at RCRA corrective action and Superfund remediation sites. See 40 CFR 264.1080(b)(5). Control measures at those sites for volatile organics are established on a site-specific basis.

result since the metals would be immobilized and the organics removed (by being driven off during the stabilization process) and destroyed (by the subpart CC controls). The Agency has also issued guidance on possible controls of these emissions that are considered to be Best Management Practices for contaminated soil. See Best Management Practices (BMPS) for Soil Treatment Technologies, EPA530-R-97-007, May 1997, www.epa.gov/epaoswer/hazwaste/ca/resource/guidance.htm. These practices likewise should result in adequate control of hazardous organic constituents driven off during the course of treatment, and so should result in permissible treatment.

(b) For hazardous wastes containing organic constituents, we would likely conclude that impermissible dilution occurs when the amount of organics in the waste interferes with performance of selected stabilization reagents (e.g., high levels of organics may prevent the other hazardous constituents, such as metals, in the waste from bonding adequately with the stabilization reagents). In this case, stabilization is an inappropriate treatment method for metals in the waste, since their mobility is not in fact reduced.

2. Considerations Pertinent to Evaluating Whether Stabilization Can Be Used To Meet an LDR Treatment Standard for Hazardous Organic Constituents

For hazardous organic constituents, the LDR treatment standards are codified in 40 CFR §268.40 for each hazardous waste code and in 40 CFR §268.48 as Universal Treatment Standards (UTS). These standards state, in almost all instances,⁶ that compliance is based on determining the amount of hazardous organic constituent in a sample of the waste. See 40 CFR §268.40 (a) (1) (“[a]ll hazardous constituents in the waste or in the treatment residue must be at or below the

⁶ The treatment standards for carbon disulfide, cyclohexanone, and methanol are based on analysis of a toxicity characteristic leach procedure extract.

values found in the table for that waste ('total waste standards')). The "total" amount of hazardous constituent present necessarily is determined through waste analysis (and indeed, the rules directly contemplate that waste analysis must occur. See, e.g. 40 CFR §268.7 (b) (2) (treatment facility owners and operators "must test the treatment residues ... to assure that they meet the applicable treatment standards"); 40 CFR §268.40 (d) (3) (use of "good-faith analytical efforts" to demonstrate compliance for treatment residues from combustion); 55 FR at 22541-42 (June 1, 1990) (discussion of demonstrating compliance by means of measurement of hazardous constituent concentration in treatment residues)). A total waste analysis of a nonwastewater involves exposing a representative sample of the waste to an aggressive extractant, normally some type of solvent (e.g., SW-846 Methods 3540 Soxhlet Extraction or 3541 Automated Soxhlet Extraction for semi-volatile organics). These solvents are expected to extract the "total" amount of hazardous organics from the waste.

It also should be noted that most of the treatment standards for nonwastewaters are based on the performance of treatment technologies like combustion or aggressive distillation, which destroy or remove the hazardous organics from the waste. See 40 CFR §268.40 Treatment Standards for Hazardous Waste Table footnote 5. Notwithstanding, compliance remains demonstrated by showing that the total waste standard in 40 CFR §268.40 is satisfied, and this entails waste analysis, as just discussed. We thus do not interpret the rule language as requiring that the standards can only be met by treatment technologies that destroy or reduce the total concentration of hazardous organic constituents providing that a total waste analysis demonstrates compliance (i.e., shows a concentration equal to or less than the amount in 40 CFR §268.40), and that compliance is achieved through legitimate means – by some means not involving

impermissible dilution. We address how this can be shown in the following paragraphs.

When a waste containing hazardous organics has been stabilized and the resultant total waste analysis for those constituents are lower than the numerical LDR treatment standards, a principal question is posed – whether immobilization has occurred or whether the standards were achieved through impermissible dilution. There is also a related technical question as to whether a “total waste analysis” could ever be considered to show that immobilization has occurred. A technical basis exists to support the view that it can.

Many stabilization reagents (e.g., clays, silica, alumina, and activated carbon) have highly adsorptive and bonding properties that can immobilize certain organic constituents. The effects can result from a range of bonds from van der Waal’s or hydrogen (i.e., electrochemical bonds) to chemisorption (i.e., formation of bonds between the surface molecules and the stabilization reagents). Chemisorption bonds are comparable in strength to chemical bonds. See La Grega, M. Buckingham, P. Evans, J., Hazardous Waste Management, McGraw Hill, Inc., New York 1994 at pp. 476-486, 649-50, and 657-652 and Lewis Sr., Richard J., Hawley’s Condensed Chemical Dictionary, Van Nostrand Reinhold Company, New York 1993 at pp. 25 and 254.

As noted earlier, a typical “total waste analysis” uses organic solvents and aggressive conditions and is designed to extract all of the hazardous organics out of the waste. Sometimes a comparison of the “total waste analysis” of the untreated wastes to the stabilized waste indicates that not all of the organics were extracted from the stabilized waste, notwithstanding use of organic solvents in an aggressive manner. One could conclude that these organics have been very strongly adsorbed by the stabilization reagents.

As such, a “total waste analysis” for a hazardous organic constituent that is under the

treatment standard can be used to demonstrate that effective immobilization has occurred.

Compliance with the numerical treatment standard can thus be demonstrated and, more importantly, as required by section 3004(m), the constituents would be substantially immobilized for purposes of minimizing the short- and long-term threats to human health and the environment.

We now clarify how permissible stabilization of hazardous organic constituents can be potentially identified (i.e., where impermissible dilution would not be occurring):

(a) As described above, “total waste analysis” extraction procedures can be used to determine the total hazardous organic content in a waste prior to its being treated to stabilize the organic constituents. Following stabilization treatment, the same extraction procedures can be used on the treated waste, and the resultant measured reduction in organic concentrations is a demonstration that the constituents have been immobilized by the stabilization reagents. Thus, there are two questions being addressed when using a “total waste analysis” method: 1) what is the total content of hazardous organics prior to treatment; and, 2) is there a resultant reduction of the measured total content of hazardous organics following stabilization? Both determinations require that proper QA/QC procedures be used for each analysis.

We recommend that waste treaters first have their laboratories demonstrate analytical procedures that are appropriate and that achieve acceptable QA/QC performance to determine total hazardous constituent concentrations in the untreated waste. Where applicable (i.e., situations where treatment residues may have difficulty achieving acceptable QA/QC performance), waste treaters can then use the same extraction procedure and QA/QC procedures on the treated waste and use the results to determine whether there has been adequate treatment. As a general case, and assuming proper QA/QC, EPA is willing to accept that the inability to

extract the hazardous organic constituents in the stabilization residues is an expected result of excess adsorptive capacity when treating with highly adsorptive stabilization reagents (e.g., clays, silica, alumina, and activated carbon). We do not consider this to be impermissible dilution because there is a known physical mechanism to explain why the technology could be immobilizing the hazardous organic constituents and not just diluting them with reagents.

(b) New adsorptive stabilization reagents such as modified clays, zeolites and specialized activated carbon have been specifically developed to entrap or immobilize certain types of hazardous organic constituents, particularly some of those found in contaminated soils. For the most part, the adsorbed organics cannot be easily desorbed. There are, however, certain conditions under which the adsorbed organics could desorb. For instance, co-disposal with other organic wastes could cause the adsorbed organics to desorb, and changes in the disposal conditions, such as fluctuations in pH, may have similar impacts. We recommend that stabilization reagents be examined on a site-specific basis to determine that they will be effective in the pH range expected in the leachate and that their adsorptive capacity would not be exceeded as the waste ages over time. These factors should be considered by the implementing regulatory agency. The use of these stabilization reagents to control the mobility of the hazardous organic constituents can thus be considered to provide substantial treatment through immobilization rather than being a type of impermissible dilution.

(c) Another consideration in assessing impermissible dilution is whether the immobilization shown by the “total waste analysis” would last under actual disposal conditions. See 63 FR at 28566 (May 26, 1998) (impermissible dilution where seeming-immobilization really resulted from ‘blinding’ the analytic method, but the hazardous constituents actually were mobile under actual

disposal conditions); Columbia Falls v. EPA, 139 F. 3d 914, 923 (D.C. Cir. 1998) (a model – in this case, the analytic method, must bear a rational relationship “to the reality it purports to represent”). At least with some organic constituents, there is reason to think that a true immobilization effect can occur, as explained above. If the “total waste analysis” is not simply blinded by the addition of stabilization reagents, then the resulting data from that test can be a demonstration that the organic constituents are sufficiently immobilized. We also do not anticipate that the stabilized organic wastes would be exposed in the short term to anything in the real world (i.e., actual disposal conditions) as aggressive as the extracting conditions used in any “total waste analysis”.

C. What Additional Factors Should Be Considered To Evaluate Whether Impermissible Dilution Is Occurring?

The fundamental treatment principle underlying stabilization technologies for metal-bearing hazardous wastes is immobilization of the metals. However, under very specific circumstances, stabilization processes can provide some degree of treatment (i.e., destruction and removal or immobilization) of certain organic constituents, as already explained above. These factors need to be considered when making a site-specific determination on whether impermissible dilution is occurring from stabilization of wastes that contain some hazardous organic constituents.

Conventional stabilization technologies are typically designed to immobilize metals and other inorganic constituents. The UTS levels for most metals are, in fact, based on the use of stabilization technologies. In addition, stabilization of treatment residues from well-designed and well-operated destruction and removal technologies is often necessary to entrap residual metals. When used after well-designed and well-operated destruction or removal technologies (or a

treatment train of such technologies), stabilization ordinarily is acceptable for metal wastes even if low trace levels of residual organics are also present⁷.

For certain hazardous wastes, some stabilization reagents may produce adverse effects that are harmful to human health and the environment. One example is stabilization reagents that also are expected to act as oxidizers or reducing agents for the targeted hazardous organics. These types of stabilization reagents should be carefully added so that any vigorous reactivity and resultant breakdown products are not released in an uncontrolled or unsafe manner. This not only is common sense, but failure to do so would be a strong indication that threats to human health and the environment are not being minimized. See Chemical Waste Management v. EPA, 976 F. 2d at 18 (vacating treatment standard that failed to control potential for uncontrolled reactivity during treatment process). The breakdown products anticipated should also be examined for their leachability. A second example of stabilization reagents that may produce adverse environmental effects, in this case due to ineffectiveness, is alkaline stabilization reagents (e.g., lime, quicklime, cement kiln dust, and black lime⁸). These reagents may increase the leachability of constituents subject to treatment whose solubility increases with pH (e.g., arsenates, chromates, amphoteric metals, phenols, water-soluble amines).

Conclusion

This memorandum is intended to clarify the potential permissibility of the stabilization of

⁷ Some organics may be present at very low concentration, that is below the treatment standards, in treatment residues such as incinerator ash. When these residues are stabilized for metals, additional immobilization may be occurring for these low levels of organics. Treatment of residual organics is not required, however, so long as those levels are below UTS, as they would be after properly operated combustion treatment.

⁸ Black lime is a waste lime produced as a by-product from acetylene production and contains carbon residuals. It is often used as a substitute for lime in stabilizing metal-bearing wastes.

hazardous wastes, including soils, containing hazardous organic constituents under current EPA rules. We are aware of the confusion that may exist in the field, especially at remediation sites, about the use of stabilization techniques to treat these wastes and soils. Full and proper consideration of the criteria set forth in this memorandum will, we believe, establish a basis upon which a generator, treatment facility, or regulatory agency can evaluate whether stabilization of organics is a technically and legally appropriate form of treatment to comply with LDRs. We encourage waste treaters to adequately document that these criteria have been fully explored and evaluated. Otherwise, the Agency could consider the use of stabilization for hazardous organic constituents to be inappropriate and to be a situation in which impermissible dilution would be deemed to occur.